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THEORIES OF SPECULATION

By
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W.P. #402 November 1985

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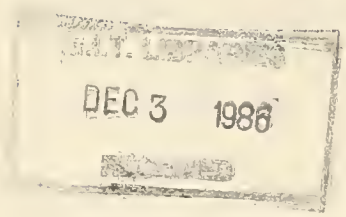

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1. Introduction.

The concept of "speculation" has always fascinated academics and members of the economic and financial community. Part of this fascination certainly comes from the fact that there is no well-accepted use of the word.[1] Various definitions have been offered to cover some of the many important facets of asset markets. The purpose of this comment is to briefly review and discuss these definitions.

2. Forecasting future returns.

a) To start the review, it is useful to briefly come back to the economic set-up behind the theory of asset markets. As is well-known, in an (Arrow-Debreu) economy with complete markets, all transactions occur initially and only trades that are contracted for at date zero are implemented in the future. Markets need not reopen. This implies that agents do not have to forecast future prices. They, at most, form beliefs about the exogenous parameters of the economy.

When markets are incomplete and reopen over time, forecasting future returns becomes important. This is true even if markets are "essentially complete", i.e., if the set of existing assets spans the set of possible returns. Indeed, a necessary condition for essentially complete markets to perform the role of complete markets (and allow the economy to reach Pareto efficiency) is that traders perfectly foresee future prices (be they spot prices as in Arrow [1964] or asset prices as in Guesnerie-Jaffray [1974]).

Giving a non-trivial role to asset markets implies that the traders forecast future prices (endogenous variables) and act on these forecasts. This forecasting activity may well correspond to the most frequent use of the word "speculation" in the non-academic world.[2]

b) Let us next review the motives that lead agents to trade on asset markets. To simplify the taxonomy, let us consider an asset which represents a claim to some exogenously given (but possibly random) amount of real consumption tomorrow. Thus, we ensure that we focus on the trading of paper claims to consumption rather than on the creation or transformation of a real good.

Under rational expectations, traders will trade only if there exist gains from trade.

The first -- and simplest -- way to obtain this is to introduce insurance motives. Asset markets are then seen as (generally imperfect) substitutes for Arrow-Debreu contingent markets. This is a well-developed theme in finance theory (starting with Keynes and Hicks). For instance, futures markets are means for producers with a risky output to hedge (for recent papers using this approach, see Danthine [1978] and Bray [1981]). "Speculators" (a more appropriate name might be insurers) are often defined as those traders with a riskless initial position, who are willing to share some of the producers' risk for a risk premium.

Second, some papers posit the existence of an exogenous (and possibly random) supply of (or demand for) the asset -- or, more generally, this supply component does not explicitly come from an optimizing behavior (see, Admati [this volume] for a clear review of this approach). The existence of such supplies gives rise to gains from trade for the set of "rational" traders.

A third way of obtaining gains from trade considers the life cycle aspect of savings. We will come back to this in detail in section 4.

Fourth, traders may have "different beliefs" about the dividend (number of units of real good) attached to the asset. The word "beliefs" must be

made precise. As a starting point, consider a simple Bayesian context in which the traders have the same priors about the dividend, and in which they obtain private information before trading (the structure of information is also common knowledge). Then if traders are risk-neutral[3] and have rational expectations, they have no reason to trade.[4] This simple result is natural, as we know that in such a context only different priors can give rise to "gains from trade." So "different beliefs" should be taken to mean "different priors" rather than "different information", if we want to create a motive for trade (see Harrison-Kreps [1978] and Hirshleifer [1975,1977] for studies of the implications of the existence of different priors). In this view speculators are traders who bet on opposite sides of the market because of their intrinsically divergent views of the world.

Lastly, I should mention the related literature on sequential trading with complete or incomplete markets (on whether agents trade again when markets reopen) -- for a review of this literature, see Hirshleifer-Riley (1979, section 2.2).

• Remark: Interesting features of asset markets, e.g., price dynamics, can be obtained even in the absence of gains from trade. For instance, in a one consumer economy, implicit asset prices can be computed, that would clear asset markets if these were introduced (see, e.g., Lucas [1978]).

3. Endogenous supply of goods.

In this section, we focus not on the reallocation of exogenous claims to real consumption between traders, as we did in the previous taxonomy, but on the supply of a given commodity. To some extent this is part of production theory. For instance, the Henderson-Salant (this volume) gold suppliers

decide on when to put ore on the market for consumption, in the tradition of Hotelling [1931]. To do so, they forecast the influence of exogenous shocks to the supply of gold on the market price. "Speculators", in this sense, are suppliers of a commodity, who choose the date of supply. No trading of paper claims to the good need be involved.

This definition of speculation is adopted in a number of contributions that followed Friedman [1953]'s discussion of "stabilizing speculation" (e.g., Samuelson [1971], Schechtman-Scheinkman [1983], Salant [1983,1984], Hart-Kreps [1984], Townsend [1977], Newberry-Stiglitz [1981] and references therein). Most of these contributions focus on storage, a special case of a production technology. Speculators buy the good on the spot market to resell it later on on the spot market. Friedman argued that storage has a stabilizing influence -- roughly, speculators buy the commodity on the spot market when the price is low and resell it when the price is high. So storage activity ought to be "stabilizing". There are lots of definitions that can be given to "stabilization" -- See Hart-Kreps for a very lucid discussion of this. Unfortunately, the Friedman proposition does not always hold. Hart-Kreps and Salant offer examples in which a storage activity is destabilizing. Let us give the flavor of the Hart-Kreps example in which speculation, by all possible definitions, is destabilizing. In this example, demand is i.i.d., and can be "high" or "low". It is inelastic when high, so that the market price is not affected by past storage. When demand is low, traders get a "signal". If the signal is pessimistic, they do not store and thus the current spot price is again unaffected by speculation if there has been no storage before. If the signal is optimistic, they do store. This leaves the current price unaffected as the low-state demand is inelastic for "normal" consumption. However, the low-state demand curve is downward-sloping for

the good and the activity that reallocates this supply of the good over time (storage). The equilibria with and without storage are then compared. However, in general, the initial supply is hardly exogenous. Investment and the choice of technology change the date of availability of commodities. Most forms of production thus have a speculative aspect to them, in the sense that they adapt the intertemporal supply of goods to expected market prices.[5] Thus this definition of speculation may be too broad.

4. Asset bubbles.

Let us come back to the financial side of the economy, considered in section 2. To this purpose, we ignore the production process (section 3) to simply consider a claim that entitles its owner(s) to a flow of exogenously given dividends (i.e., units of real consumption): $\{d_t\}_{t=0,1,\ldots}$. For simplicity, let d_t be deterministic for the moment.

In the rest of the paper we focus on a definition of speculation which is due to Keynes [1936], and which was more recently used by Harrison-Kreps [1978]. This definition links speculation with the prospect of capital gains. To this purpose, let us consider the following thought experiment: suppose that there exists an infinitely-lived agent (or family with strong bequests motives), and that, at date t, she is asked the following question: "Assuming that reselling the asset is prohibited, how much are you willing to pay for the asset?" If the capital market is perfect and r_t denotes the real rate of interest at time t, the agent answers:

$$(1) \qquad F_t = \sum_{s=1}^{\infty} \frac{d_{t+s}}{(1+r_{t+1})\ldots(1+r_{t+s})} ,$$

in terms of real consumption. F_t, the real value of the asset, is called its market fundamental.

higher consumptions; if next period's state of demand is low again, but next period's signal is pessimistic, there will be an increase in supply due to current speculation and a decrease in the spot price relative to the speculation-free case. So, most of the time, speculation does not affect the price, and the rest of the time, it reduces it when it was already low.

The word "stabilization" (like "speculation") has always exercised much fascination. However, it is not clear why we should care about this concept at all, as many authors have recognized (e.g., Hart-Kreps, Newberry-Stiglitz and Salant). Salant even argues that "the Friedman proposition is not merely wrong ... It is also uninteresting." Indeed, the standard criterion for evaluating the desirability of economic activities is welfare or Pareto efficiency. "Stabilization", despite its seeming intuitive appeal, has no clear connection to Pareto optimality.

We know that a competitive equilibrium of an economy with production and complete markets is Pareto optimal. This applies in particular to economies with storage, which, as we said, is a special instance of production. Next, consider an economy with risk neutral traders, as is done in most contributions. The absence of complete markets then need not prevent the competitive economy from reaching Pareto optimality. Indeed, the equilibria of the storage economies considered in Samuelson, Newberry-Stiglitz and Schechtman-Scheinkman are Pareto optimal.

The effect of expectations on the supply of commodities has a lot of important facets, as shown by the above-mentioned contributions and by many others. I would formulate a slight (and unimportant) criticism of the use of the word "speculation" here. Giving content to this use generally consists in studying the economy with and without speculators. This explains why most contributions create a dichotomy between an exogenous intertemporal supply of

In a certain, perfect foresight world, any asset is priced by arbitrage; the asset's price p_t (in terms of real consumption) must satisfy:

$$(2) \qquad (1+r_{t+1})p_t = p_{t+1}+d_{t+1} \ .$$

This first-order difference equation has a priori a family of solutions of the type:

$$(3) \qquad p_t = F_t+B_t \quad , \text{ where } B_{t+1} = (1+r_{t+1})B_t \ .$$

The family of solutions is indexed by the initial value of the B_t sequence (B_0). Furthermore, it is easily shown that, if the asset can be freely disposed of, B_t must be non-negative.

B_t, the excess of the price over the market fundamental is called the asset bubble. In an economy with infinitely lived agents, it is a measure of how much traders are willing to pay for the right to resell the asset.

a) Conditions of existence of a bubble. We already mentioned that a bubble must be non-negative. Can it be strictly positive? An obvious requirement for a bubble to exist is that the asset be infinitely lived: if it is known that the asset stops being traded at time T, then at time T, $p_T = F_T$ (= 0 if dividends also stop being distributed after T). Thus, at (T-1), from the arbitrage equation, $p_{T-1} = (d_T+p_T)/(1+r_T) = F_{T-1}$. So, $B_{T-1} = 0$. By backward induction, $B_0 = 0$.

Even if the asset is infinitely-lived, an analysis of the economic environment surrounding the asset market is required to determine whether a bubble can exist. Although this is not crucial for finance theory, it is worth mentioning the existence conditions.

Consider first an economy with a finite number of infinitely lived traders. It can be shown that no bubble can exist in such an environment (see

Tirole [1982]). This proposition, which is very general (one could, for instance, introduce asymmetric information or short sales constraints), rests on a simple intuition. From an aggregate point of view, the asset is worth exactly its market fundamental; any trading is bound to be a zero-sum game. Suppose that there exists a bubble on the asset. A possible trading strategy for an asset holder at date zero consists of selling the asset and leaving the market. This trader would then obtain more than the real value of her initial holdings. The set of remaining traders would then be stuck with an asset that they would have paid more than what it will collectively be worth to them. More generally, the asset holder(s) might want to leave the market later on, but with a finite number of traders, not everyone can quit the market in finite time without someone being stuck with the asset (the "hot potato").

This suggests that we look at economies in which there is a constant inflow of new traders so that everyone can realize her capital gains without anyone being stuck with the asset. Samuelson [1958] built the first example of such an economy: the overlapping-generations model. He showed that in a model in which traders have finite lives, an asset that does not distribute dividends ($d_t = F_t = 0$) can have a strictly positive price (such an asset is called a pure bubble). The Samuelson model has later been worked thoroughly in too many contributions to be quoted here. Let us mention that the issue of bubbles is, in general, distinct from the issue of indeterminacy of equilibria in overlapping generations economies, although, in the original Samuelson model, the indeterminacy is entirely due to bubbles (Burmeister, et. al. [1973] show that in an economy with k capital goods, there can exist a continuum of equilibria converging to a given steady state. Kehoe-Levine [1985] show that the same phenomenon can occur in overlapping-generations

exchange economies and study the dimensionality of the equilibrium set. Both results do not rely on the existence of bubbles). However, even in overlapping-generations economies, bubbles may not exist. The general equilibrium set-up may introduce "wealth constraints" that eliminate bubbles. The possibility of existence of bubbles roughly hinges on the comparison between the rate of interest of the "bubbleless" economy and the rate of growth of the economy. If the rate of interest exceeds the rate of growth, the bubble, which by arbitrage grows at the rate of interest, grows faster than the economy, so that at some point in time the savers cannot afford buying the asset from the dissavers. Let us simply mention that bubbles affect the interest rate by crowding out other assets such as capital and rents, and that only a study of underlying preferences, technology and alternative assets can determine the conditions of their existence.[6]

• Remark: Stochastic bubbles. The exposition has up to now assumed that bubbles are deterministic. But, just as the market fundamental of an asset can be stochastic (as in Henderson-Salant),[7] its bubble can also be stochastic. In particular, the bubble and thus the asset price, can be contingent on "irrelevant" variables such as sunspots. Blanchard [1979a] gives an example of a bubble that bursts with positive probability at each period; it must then grow at a rate exceeding the rate of interest to offset the probability of bursting. Weil [1983] demonstrates the conditions under which such a phenomenon is consistent with general equilibrium. Similarly, Azariadis [1981] and Azariadis-Guesnerie [1983] construct economies in which a bubble follows a stationary process.

The latter general equilibrium approaches construct stochastic aggregate bubbles. But even if the aggregate bubble, i.e., the sum of bubbles on all

assets, is deterministic, the bubble on a particular asset need not be. If there exist several bubbly assets in the economy, there can be stochastic bubble substitution between these assets. The bubble on asset A can grow at the expense of that on asset B if there is a sunspot, and the reverse if there is no sunspot.

The possibility of the existence of a stochastic bubble naturally matters for tests of asset pricing, as many of these tests rely on the absence of a bubble (see, e.g., Shiller [1981], Leroy-Porter [1981], and for an econometric estimation with bubbles, Blanchard-Watson [1982]).

b) Criticism of the market fundamental/bubble distinction.[8]
While the price of an asset can always be decomposed into a market fundamental and a bubble, this decomposition is not satisfactory for some assets. We mention here two main reasons for this.

b1) The dividend may not be independent of the market price. The previous assumption that d_t does not depend on p_t, may be violated for some assets. To illustrate this, consider a diamond. Its dividend normally represents the enjoyment corresponding to looking at the diamond. It is then expressed in real terms, independently of the diamond's price.[9] However, in an economy in which snobism effects exist, consumers may "enjoy" a diamond more if its price is higher (note that "enjoying more" refers to the dividend, and is distinct from "being willing to pay more than for an artificial diamond", which can come from a bubble). This clearly creates problems with the dichotomy. Indeed, one can show that if, at each period, the dividend is proportional to the asset price, and if the coefficient of proportionality does not go to zero, then there cannot exist a bubble on the asset (while, for most assets, a bubble is feasible as long as the economic environment satisfies the conditions mentioned in a)). But there can then exist a multi-

plicity of market fundamentals. This reasoning also matters for an asset like money, whose liquidity value depends on its price in terms of real good.

b2) "Backed assets". The second caveat in the dichotomy lies in the fact that some assets are backed, in the sense that their price cannot fall below some lower bound under which the asset would be used differently.

Consider the following metaphor. The produced good of Schmooland, the schmoo, is white. However, by a fluke, firms at date zero produce a few black schmoos. Everyone agrees that this productive miracle will never occur again. Also, it turns out that black and white schmoos are perfect substitutes in the consumers' utility function, and that moreover, black schmoos are costlessly storable. At date zero, everyone feels that, due to their scarcity, the black schmoos ought to be priced above the white schmoos; their price is equal to two, say, in terms of white schmoos. Assume that the rate of interest is zero. The price of black schmoos is then two forever. Thus, black schmoos are never consumed. They yield no dividend. Their market fundamental is equal to zero, and the bubble is equal to two.

Although there is no difficulty here, few people would say that the real value of black schmoos is zero. To give content to this objection, notice that, were their price to fall below one, the black schmoos would be consumed (i.e., destroyed as assets). Thus, the market fundamental does not necessarily represent the lower bound on the asset price. Along these lines, one can notice that, were the price of gold to fall considerably, the consumption of gold (dentistry, jewelry, engineering, etc.) would soar. Again, the real lower bound on the gold price (see Henderson-Salant for the computation of such a lower bound) exceeds the market fundamental of gold (zero, since gold ingots do not distribute dividends). Similarly, the lower bound on the

stocks of the firm that does not distribute dividends exceed its (zero) market fundamental (for instance, in a perfect foresight frictionless economy, the lower bound equals the present discounted value of profits, rather than dividends).

c) Linear models. The word "bubble" is also commonly used in linear models.[10,11] These models often start from a first-order difference equation. For instance, Flood and Garber use a Cagan money demand equation:

$$(4) \qquad m_t - p_t = -\alpha(p_{t+1} - p_t) \ ,$$

where m_t = log of money stock, p_t = log of price of real consumption in terms of money (note that the notation differs from the previous one, which considered the price of an asset in terms of real consumption). Stochastic elements are usually added, but are irrelevant to our discussion. Integrating (4), one obtains a family of solutions which are the sum of a "particular solution" or "forward solution": p_t^F, and a "general solution" A_t of the homogenous equation (indexed by its initial value A_0):

$$(5) \qquad p_t = p_t^F + A_t \ ,$$

where: $$p_t^F = \sum_{s=0}^{\infty} \frac{\alpha^s}{(1+\alpha)^{s+1}} m_{t+s} \quad \text{and} \quad A_{t+1} = \frac{1+\alpha}{\alpha} A_t \ .$$

The particular solution p_t^T and the general solution A_t are often called market fundamental and speculative bubble, respectively. An analogy with the concepts defined earlier is that the first-order difference equation (4) without terminal condition also generally admits a one-parameter family of solutions. However, the two definitions differ. For instance, bubbles in the linear sense need not grow at the rate of interest (and the market fundamental need not represent the present discounted value of dividends).[12,13]

Footnotes

[1]The Oxford Universal Dictionary gives several meanings to the word "speculation". The ones of interest for our discussion are: 1) "The faculty or power of seeing"; 2) "The exercise of the faculty of sight"; 3) "The action or practice of buying and selling goods, stocks and shares, etc., in order to profit by the rise or fall in the market value, as distinct from regular trading or investment."

[2]Sometimes speculation is even used to describe the forecast of exogenous variables such as the stock of oil in a field.

[3]This feature is not crucial, but, by ruling out insurance motives, allows a strong characterization.

[4]See Kreps [1977, section 6] for the original statement and proof of this result, Milgrom-Stokey [1982] for a generalization to more complex exchange economies and risk aversion, and Tirole [1982] for an extension of Kreps to a T-period model, in which traders receive private information over time.

[5]The Henderson-Salant gold owners example is also somewhat damaging for the dichotomy. If the fixed stock of gold is costlessly extracted and stored, it can either be entirely extracted and sold at date zero, in which case storage plays an important role, or it can be extracted to face demand at each period, in which case there is no storage. The two possibilities give rise to the same price path and owners' profits.

See also Benabou [1985], who looks at the strategic behavior of a monopolist who faces consumers who can store, has a cost of changing his price and lives in a inflationary world.

[6]For a description of the crowding-out, see Tirole [1985].

[7]The papers reviewed in sections 2 and 3 rule out bubbles either explicitly or implicitly by positing a finite life for the asset.

[8]This discussion partly follows Tirole [1985, sections 7 and 8], to which the reader is referred for further details.

[9]The fact that artificial diamonds that cannot be distinguished with the naked eye from real ones command much lower prices does not contradict this statement. The difference may correspond to a bubble. If this hypothesis is correct, the price of an artificial diamond is a measure of the market fundamental.

[10]These have been throroughly developed by, among others, Blanchard [1979b], Blanchard-Kahn [1980], Burmeister et. al. [1983], Flood-Garber [1980], Gourieroux et. al. [1982], Diba-Grossman [1985], and Taylor [1977].

[11]Note that equation (2) above is linear only to the extent that the asset is small relative to the economy. (p_t has no influence on r_t). But even if the asset is big relative to the economy, (2) can be integrated to obtain the dichotomy equation (3).

[12]Money is often the only asset in these economies. The rate of interest must then be obtained from the intertemporal marginal rate of substitution. Or else one can introduce other assets, such as capital in the economy.

[13]A non-semantic issue has to do with the use of linear models. Some (including myself) feel somewhat uncomfortable using such models to study solutions that may explode. Even if (4) can be derived as a one-period approximation of an optimizing model, it seems safer to use the non-linear version of the model the way Brock [1975] and Obsfeld-Rogoff [1983] do for this model, for instance. Let us note in passing that these authors derive conditions under which a multiplicity of market fundamentals for money (in the sense of 3a) and b)) can exist.

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